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The effectiveness of 4mat teaching model in overcoming learning difficulties in the perimeter and area of circle and perpendicular cylinder among the seventh year students

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Abstract

The aim of this study is to determine the learning difficulties in the perimeter and area of circle and perpendicular cylinder of the seventh year students in primary education, and to determine the effectiveness 4MAT teaching model overcoming learning difficulties. The study is planned as with pro-test, last-test control group experimentally design model. The study is applied to 83 students (primary school, 7. class). The findings of this study indicated that students had had learning difficulties about the perimeter and area of circle and perpendicular cylinder, and 4MAT based teaching was effective in overcoming these difficulties, whereas, traditional method was not effective in overcoming learning difficulties.

Keywords: Learning difficulties, 4MAT teaching model

1. Introduction

Even though learning difficulty covers a very wide range of area, in mathematics 'learning difficulty' refers to some kind of certain inadequacies peculiar to the field. (Durmuş 2007) It is very hard for a student having learning difficulty in a subject to be successful in the subsequent subjects. (Dikici and İşleyen, 2004) That's why, the learning difficulties the students have should be determined quickly and eliminated immediately. (Duval 2002) Seeing that it is a necessary but hard task to improve comprehension in mathematics, it can be said that recognizing the learning difficulties faced by students in mathematics and the sources of these difficulties and designing a teaching model to eliminate these problems is a very crucial step towards achieving this task (Yetkin 2003). Considering the questions in teaching geometry, recognizing the learning difficulties and searching for ways to eliminate them comes as a necessity.

The aim of this study is to determine the learning difficulties in the perimeter and area of circle and perpendicular cylinder and to find out the effects of the 4MAT-based teaching model on improving students' success and overcoming learning difficulties.

In line with the aim of the research, the questions below are tried to be answered.

1. What are the difficulties of 7. class students on the subject of the perimeter and area of circle and perpendicular cylinder? ,2. Is there any noticeable and meaningful difference between experimental group and control group with

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regard the success rate in the subject of the perimeter and area of circle and perpendicular cylinder?,3. What are the effects of 4MAT teaching model in overcoming learning difficulties?

2. Method

In this research, "case study model" is used to determine the learning difficulties and pro-test, last-test control group experimentally design model is used to determine the effects of 4MAT learning model in learning difficulties in learning the subject of the perimeter and area of circle and perpendicular cylinder. The subjects are chosen randomly; the research is carried out with 66 students from 2009-2010 academic year and 83 students from 2010-2011 academic year, all of whom are 7^{th} grade students.

2.1. Data Collection and Analysis

In this research, a test with 14 open-ended questions is prepared to determine the learning difficulties in the subject of the perimeter and area of circle and perpendicular cylinder. Also, expert opinion is consulted to find out whether the questions measure the acquisitions in question and necessary regulations are made. The preliminary test is applied to 8^{th} grade students at first and Cronbach Alpha Reliability Coefficient is found to be 0,79. There are made semi-structured interviews with 15 students to determine the learning difficulties in detail. 42 students in the experimental group studying in 2010-2011 academic year are taught how to calculate the perimeter and area of circle and perpendicular cylinder with plans prepared according to the 4MAT learning model. Taking into consideration the eight acquisitions aimed in the program, an achievement test consisting of 24 multiple choice questions is prepared to determine the effect of the model on the students' success. The reliability of the measure is found to be 0,80. The achievement test is applied to the experimental and control groups before and after teaching. Afterwards a test determining the learning difficulties is applied to experimental and control groups in order to find out the effect of 4MAT learning method on overcoming learning difficulties. While the answers acquired from the learning difficulties determination test are evaluated in the analysis of the data, the answers in question are divided into four and examined in these different categories, which are namely "true", "partly-correct", "false" or "unanswered". To explain these categories one by one; *true* is the situation in which the students find all the required information asked in the question; partly-correct is the situation in which the answer of the students includes only a certain part of the required information, calculation error or imperfect data; or lacks the final step to the solution of the problem; *false* is the situation in which the students finds an incorrect answer with an completely wrong approach; *unanswered* is the situation in which the students leave the question without giving any answer. In accordance with the results of the categorization, a percentage and frequency distribution is drawn. The interviews are analyzed descriptively. A t-test is applied to find out whether there is any noticeable and meaningful difference between the success levels of the experimental and control groups.

3. Findings and Comment

1. The learning difficulties in the subject of the perimeter and area of circle and perpendicular cylinder

In this research, a test with 14 open-ended questions is prepared to determine the learning difficulties in the subject of the perimeter and area of circle and perpendicular cylinder. Also, expert opinion is consulted to find out whether the questions measure

Table 1. The Results of Learning Difficulties

Question Type	True		Partly-correct		False		Unanswered	
	f	%	f	%	f	%	f	%
1. Calculating the perimeter of a circle whose radius is given in the question	40	60.6	13	19.7	10	15.1	3	4.6
2. Calculating the perimeter of a circle whose diameter is given in the question	28	42.4	11	16.6	23	34.8	4	6.2
3. Calculating the length of a certain part of a circle	37	56.1	15	22.7	11	16.6	3	4.6
4. Realizing the relationship between a part of a circle and the arc of a circle	33	50.0	16	24.2	9	13.6	8	12.2
5. Solving the problem about the length of a circle and length of a certain part of a circle	22	33.2	12	18.2	19	28.9	13	19.7
6. Calculating the area of a circle whose radius is given	41	62.1	13	19.7	10	15.1	2	3.1
7. Calculating the area of a circle whose diameter is given	30	45.5	11	16.6	23	34.8	2	3.1
8. Calculating the area of a circle whose perimeter is given	34	51.6	19	28.9	10	15.1	3	4.6
9. Calculating the area of a segment of the circle (realizing the relationship between central angle and the area of a segment)	19	28.9	10	15.1	26	39.4	11	16.6
10. Solving the problem about the area of a circle and the area of a segment in the circle	25	37.9	10	15.1	17	25.8	14	21.2
11.Calculating the surface area of a perpendicular cylinder	24	36.4	12	18.2	21	31.8	9	13.6
12.Solving the problem about the surface area of a perpendicular cylinder	19	28.9	8	12.2	29	43.8	10	15.1
13.Calculating the volume of a perpendicular cylinder	34	51.6	12	18.2	11	16.6	9	13.6
14. Solving the problem the volume of a perpendicular cylinder	21	31.8	11	16.6	19	28.9	15	22.7

All Examining the answers, it is seen that 66 % of the students gives the *right* answer and 19,7 % gives the *partly-correct* answer to the question which measures the ability of calculating the perimeter of a circle whose radius is given. This finding shows that students don't have much difficulty in the first question and those who gives half-correct answer make calculation error. 42,4% of the students gives the *right*, 16,6 % of the students gives *half-correct* answer to the question which measures the ability of calculating the perimeter of a circle whose diameter is given while the answer of 34, 8 % is *false*. The rate of right answers in the second question is relatively low than the first. This finding shows that there is a learning difficulty in calculating the perimeter of a circle whose diameter is given. In an interview with a student who gives wrong answer, the student is asked how s/he has calculated the perimeter. In his/her answer it is shown that the student has made the calculation accepting the diameter as radius. 86,9 % of those who gives the wrong answer makes the same mistake and gives the same answer. 56,1 % of the students gives *right,* 22,7 % gives *partly-correct,* and 16,6 % gives *wrong (false)* answer to the question that measures the ability of calculating the length of a certain part of a circle. According to the results, it is shown that students don't have much difficulty in solving the third question and those who give partly-correct answer couldn't solve the problem because of a mistake either in calculation or in proportion. A similar result is valid for the fourth question which measures the ability of realizing the relationship between a part of a circle and the arc of a circle; sixth question which measures the ability of calculating the area of a circle whose radius is given; and eighth question which measures the ability of calculating the area of a circle whose perimeter is given. 50 % of the answers given to the fourth question is *true* while 13,6 % is *false.* For sixth question, 62,1 % is *true* and 19,7 % is *false;* while it is 51,6 % *true* and 15,1 % *false* for the eighth question. To the question that measures the ability of solving the problem about the length of a circle and length of a certain part of a circle, 33,2 % of the students gives *right,* 18,2% gives *partly-correct* and 28,9 % gives *wrong (false)*answer while 19,7 % leaves the question without giving any answer at all (*unanswered).* The fifth question which seems to be difficult for the students is just like that: "The wheel of a unicycle that an acrobat rides on a rope can make 6,5 circuits during the show. So that the diameter of the wheel is 24 cm, what is the length of the rope on which the acrobat makes his show?" In the interviews, it is shown that most of the students couldn't realize that they should find the perimeter of the circle, some of them use the diameter instead of radius, some make area calculation and some don't know how to find the length of the rope. To the question that measures the ability of calculating the area of a circle whose diameter is given, 45,5 % of the students gives *right,* 16,6 % *partly-correct* and 34,8 % gives *wrong (false)*answer. The results of this question is parallel to those of the second question. Accordingly, the learning difficulty faced in calculating the perimeter of a circle whose diameter is given is also experienced in calculating the area of a circle whose

diameter is given, too. To the question that measures the ability of calculating the area of a segment of a circle, 31,8 % of the students gives *right,* 16,6 % gives *partly-correct* and 28,9 % gives *wrong (false)*answer. This result shows that students have difficulty in calculating the area of a segment of a circle. In the interviews made with the students, it is seen that they have difficulty in realizing the relationship between the area of a segment and central angle. When asked "why have you answered the question in that way?" the student replies "radius is enough to find the area. I don't understand the use of the angle here." This reply shows that the student has difficulty in seeing the relationship between the area of a segment and central angle. Some of the students who gives wrong answer has tried to solve the problem by multiplying the angle with the overall volume of the whole circle. To the question that measures the ability of calculating the area of a circle and of a segment in the circle, 37,9 % of the students gives the *right*, 15,1% *partly-correct,* 25,8 % *wrong (false)* answer, while 21,2 % leaves the question *unanswered.* It is seen in the interview made with the students that those who answer the question wrong have understood the question correctly but couldn't establish a relation between a segment of the circle, area of the circle and the central angle. It is shown that 48 % of those who answer the 9^{th} question correctly give wrong answer to the 10^{th} question. A similar case is seen between the questions who measure the ability of "solving the problem about the surface area of a perpendicular cylinder" and "solving the problem the volume of a perpendicular cylinder." Respectively, the ratio of right answer to these questions is 28,9 % and 31,8 %. It is determined that student do not have difficulty in the question that measures the ability of calculating the volume of a perpendicular cylinder and give the *right* answer with a percentage of 51,6 and *partly-correct* answer with a percentage of 18,2. Whereas, to the question that measures the ability of calculating the surface area of a perpendicular cylinder, 36,4 % of the students gives *right* and 31,8 % of the students give *wrong* answer, which shows that student have difficulty in that subject. Most of the students who give the wrong answer to the 11^{th} question don't understand the open form of the perpendicular cylinder. In the interviews the students are asked how they have found the area of the cylinder and the replies of the students show that they don't know the open form of the cylinder; cannot recognize the lateral faces and bottoms; and cannot establish the relationship between the rectangular part that constitutes the lateral face and the perimeter of the bottom.

2. The Relationship between the Success Level of Experimental and Control Groups

The achievement test that carried out before and after the practice is applied with the form of a pro-test & last-test to the experimental and control groups of the research that have equal success levels (respectively 42 and 41) in the 6th grade mathematics classes and attend to the experimental part of the study. The experimental group is taught the subject of "the perimeter and area of circle and the area and volume of perpendicular cylinder with 4MAT model while the control group is taught the subject with course book. The experimental group get 26,38 from the pro-test and 75,71 from the last-test. According to the results of the paired t-test that is applied to the averages in order to determine the meaningfulness of the difference between two, the value of 't' is found to be meaningful. [t = 17.22;p=.00<.01)]. Similarly, the the students in the control group get an average of 18,05 points from the pro-test and an average of 62,71 points from the last-test. . According to the results of the paired t-test that is applied to the averages in order to determine the meaningfulness of the difference between two, the value of 't' is found to be meaningful. [t = 12,78;(p=.00<.01)]. Therefore, the teaching methods applied have an effect on increasing the success of the students. According to the findings, the point average of the experimental group in the last test in higher than that of control group, which shows a 12,66 point difference in the favor of the experimental group. . According to the results of the paired t-test that is carried out to determine the meaningfulness of this difference, it is seen that there is a meaningful difference between the average results of the last-tests. (p=.00<.01). This finding shows 4MAT teaching model to be more effective in increasing success level.

3. The effects of 4MAT Teaching Model on Overcoming Learning Difficulties

After that practice, a test determining the learning difficulties is applied to the experimental and control groups with the aim of determining the effectiveness of 4MAT Teaching Model in overcoming the learning difficulties. The answers are evaluated as "right, partly-correct, false and unanswered" and the points of 2, 1, 0, 0 are given to these categories respectively. According to the findings acquired from the study, the point average of experimental group is higher than that of the control group with a difference of 12,66 points. According to the results of the independent samples t-test carried out to determine the meaningfulness of this difference, there is a meaningful difference

between average points of the two groups. (p=.00<.01) This finding shows that the students in the experimental group answer the question with a higher ratio of correctness than the control group. The categorization of the answers given by the students in the learning difficulties determining test is given in the table 2nd. Examining the answers, it is seen that the sum of right and partly-correct answers of the experimental and control groups in the questions of 1, 3, 4, 6, 8,13 is quite high and there is no learning difficulty in the subjects which are measured by these questions. At the same time, it is seen that the learning difficulties faced by control group and measured by the other questions are parallel to the results of the1st research problem whereas the average right or partly-correct answer ratio of the students in the experimental group is relatively higher than the control group in most of the questions. It is seen that experimental group shows some learning difficulties in the subjects measured by the questions of 2,7,9,12,14. However, contrary to the control group, it shows no learning difficulty in the subjects measured by the questions of 5, 10, 11. Moreover, it is seen that the ratio of giving right answer to the questions is higher in the experimental group than control group.

4. Conclusion and Discussion

1. The learning difficulties faced in the subjects of the perimeter and area of circle and the area and volume of perpendicular cylinder are as the following;

A failure to comprehend some basic concepts sufficiently

- The concepts of radius and diameter not perceived fully- mistakes in finding the radius and diameter length and realizing the relationship between them
- An improper try to apply the formulas of area and perimeter without paying necessary attention to radius and diameter of the circle
- Mistaking the perimeter and area concepts for each other or just memorizing the formulas
- Having difficulty in calculating the length of a part of the circle or the area of a segment of a circle as a result of a failure to establish the relation between central and inscribed angles in the circle or a wrong application of the relation between the inscribed angle and the central angle facing the same arc
- Having difficulty in calculating the surface area of perpendicular cylinder as a result of a failure to understand the concept of surface area and to establish the length relations between lateral face and the bottoms

An inadequacy in transforming the verbal problems into mathematical notation

- Having difficulty in organizing, systemizing and using the information while solving the problem.
- A failure to understand what (perimeter, area or volume) is required in the problem.
- Having difficulty in solving problems as a result of not being able to transfer the concepts of perimeter, area and volume into the real-life problems in their minds
- Having difficulty in solving problems due to an inadequacy in algebraic and geometric abilities

According to the results, students have various difficulties in comprehending a variety of concepts (radius-diameter, area-perimeter, inscribed angle-central angle) and solving problems. The studies carried out in literature seem to support these findings. (Işıl and Ubuz, 2004; Özsoy and Kemankaşlı, 2004; Akuysal,2007; Yılmaz,Keşan,and Nizamoğlu, 2001) The main reason of these difficulties can be the students' lack of information in the mathematics and geometry subjects which are interwoven with each other with a prerequisite relation or having learned the subjects incorrectly beforehand. Furthermore, the quality of the education given to the students is also very important. A student may have difficulty in a very subtle point where the teacher considers the students to understand without difficulty. That's why, being aware of the possible difficulties a student may face can enable the teacher to use right method and provide effective learning. Examining the difficulties, it is seen that there are problems in learning some basic concepts. Tall (1993) says that under the learning difficulties in mathematics, there lays an inadequate comprehension of the concepts. According to Altun (2001), since the mathematical subjects have a strongly ordered structure, no concept can be understood without understanding its prerequisites. Teaching other concepts before internalizing the prerequisite concepts can be accepted as the main reason of some students' failure to establish the relationship between the concepts in question. To provide permanence for a definition or a concept

in mathematics, this element should be learned by knowing the features of its mathematical terms rather than just memorizing it without any knowledge of its content. (Çiltaş,Işık,Kar,2010) A permanent and effective learning in mathematics can only be achieved by balancing the operational and conceptual information. (Noss and Baki, 1996) Correlatively, the balance can only be achieved by establishing the relationship between operational and conceptual information. The fact that students give right or partly-correct answers with a high ratio to the questions requiring operational information but have difficulty in the questions requiring conceptual information shows that the relationship in question is not strong enough. This weak connection between operational and conceptual information affects the students' problem solving ability in a bad way and leads them to have difficulty in the questions requiring problem solving. Problem solving makes it possible to apply geometric features to the real life situations. (Işıl and Ubuz, 2004) Therefore, problem solving process is really important in relating geometric information to daily life. However, looking to the relevant literature, it is seen that problem solving does require not only operational and conceptual information ability but also some other abilities as well. Most children may have difficulty in organizing, systemizing and using the information while solving a problem. (Gür, Korkmaz and Ersoy 2004) Likewise, this finding is supported by the replies the students give in the interviews.

2. Teaching the subject of perimeter and area of circle and the area and volume of perpendicular cylinder with 4MAT model is seemed to be more effective in increasing the success level than teaching only with course book. This result is also parallel with some research findings in literature. (Tatar,2006;Dikkartın and Uyangör,2006;Peker,2003)

3. The learning difficulties determined in the first problem of the study seem to decrease in the experimental group to which 4MAT teaching model is applied. This result is parallel with the findings of the study carried out in 2006 by Tatar. Considering the development of geometrical thinking, the student should use the rules as if s/he creates the rules for the first time rather than just try to apply a great many rules given by the teacher. 4MAT Teaching Model can provide this opportunity with its student-centered and practice based structure. Moreover, the processes in the learning cycle help student very much in using the mathematical and geometrical concepts and applying them to the daily life. 4MAT teaching model which takes the concept-finding activities, daily life problems and learning cycle based on learning styles to its centre point is an effective design in overcoming learning difficulties.

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